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Fish and Wildlife Service
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In Reply Refer To:
AESO/SE
2-21-96-F-134

May 26, 1998

Ms. Cindy Lester
Chief, Regulatory Branch
U.S. Army Corps of Engineers
3636 North Central Avenue, Suite 760
Phoenix, Arizona 85012-1936

Dear Ms. Lester:

The U.S. Fish and Wildlife Service (Service) has reviewed the February 26, 1996, biological assessment (BA), the mitigation plan, an aerial photograph showing locations of Pima pineapple cacti, and the November 13, 1997, revised biological assessment (RBA) for the proposed issuance of a permit to authorize discharge of fill material into 2.7 ha (6.6 acres) of unnamed washes for the residential development of property named Las Campanas Housing Development. The named property is owned by WLC Green Valley Limited Partnership and is located in Section 10, T18S, R13E, Green Valley, Pima County, Arizona, and will be developed by WLC Green Valley Limited Partnership and Fairfield Green Valley, Inc. Your April 3, 1996, request for formal consultation was received on April 8, 1996. This document represents the Service's biological opinion on the effects of the proposed action on Pima pineapple cactus (*Coryphantha scheeri* var. *robustispina*) in accordance with section 7 of the Endangered Species Act of 1973, as amended, (16 U.S.C. 1531 et seq.). The U.S. Army Corps of Engineers (Corps) has determined that no other threatened and endangered species are affected by the proposed issuance of the aforementioned permit.

This biological opinion is based on information provided in: (1) the February 26, 1996, BA; (2) the June 19, 1996, field visit across most of the project area; (3) the mitigation plan received on May 1, 1996; with (4) an aerial photograph showing locations of Pima pineapple cacti and vegetation across the project area; (5) conversations at four meetings (in person and by conference call) on January 1, 1996, May 1, 1996, June 13, 1996, and August 5, 1997; (6) the letter received on July 31, 1996, supplementing information to the BA; (7) the May 6, 1997, letter commenting on the draft biological opinion; (8) the November 13, 1997, RBA; and (9) other sources of information. Literature cited in this biological opinion is not a complete bibliography of all literature available on the Pima pineapple cactus, the effects of urbanization or on other subjects considered in this opinion. A complete administrative record of this consultation is on file in the Tucson Sub-office of Arizona Ecological Services Field Office, 300 East Congress, Room 4d, Tucson, Arizona, 85701.

It is the Service's biological opinion that the issuance of the proposed permit to WLC Green Valley Limited Partnership and Fairfield Green Valley, Inc. as written within the "DESCRIPTION OF THE PROPOSED ACTION" of this biological opinion is not likely to jeopardize the continued existence of Pima pineapple cactus.

CONSULTATION HISTORY

Informal consultation regarding this project began with a January 16,1996, meeting. A portion of the project area referred to as G1 was undergoing the initial stages of land excavation and development to finish an existing block of housing construction. During a site visit by Tricia Roller and Angie Brooks on January 24, 1996, it was determined the G1 area was not potential habitat for the Pima pineapple cactus and that completion of the project within this block would not preclude future options involving resource conservation opportunities involving the species.

Formal consultation was initiated on April 8, 1996 with your April 3, 1996, letter of initiation. During subsequent meetings with the Corps and the applicant, the Service discussed preliminary project plans, concerns regarding the cactus, and ways to address impacts. Some of the measures to address impacts were later incorporated into the BA and mitigation plan. A supplemental letter was requested by the Service on June 13, 1996, during a conference meeting to address additional information concerning avoidance, transplantation, monitoring, and habitat evaluation. This letter, with additional information, was not received by our office within the 90-day period allocated for consultation. However, an extension was determined appropriate that provided for the consideration of this additional information. This information was received on July 31, 1996.

The Service transmitted a December 10, 1996, draft biological opinion on the proposed action as addressed within documentation received through July 31, 1996. Comments on the draft opinion were provided to the Service on May 6, 1997, and discussed in an August 5, 1997, meeting. The November 13, 1997, RBA was submitted to, received and reviewed by this office. Ultimately, a January 23, 1998, letter was received by this office on January 26, 1998 requesting the Service to analyze the new information submitted in the RBA and revise the original draft opinion.

The following list of representatives consists of the knowledgeable people affiliated with this proposed project and formal consultation process. The individuals attended meetings or provided relevant comment.

Robert Dummer	U.S. Army Corp of Engineers, Regulatory Branch, Phoenix, AZ
Tricia Roller	U.S. Fish and Wildlife Service, Ecological Services, Tucson, AZ
Angela Brooks	U.S. Fish and Wildlife Service, Ecological Services, Phoenix, AZ
Tom Gatz	U.S. Fish and Wildlife Service, Ecological Services, Phoenix, AZ
Scott Mills	SWCA Environmental Consultants Inc., Tucson, AZ
Malcolm Adair	SWCA Environmental Consultants Inc., Tucson, AZ
Mark Taylor	WLC-Green Valley Limited Partnership, Tucson, AZ
Michael Bowman	Fairfield Green Valley, Fairfield Homes Inc., Scottsdale, AZ

David Williamson — Fairfield Green Valley, Fairfield Homes Inc., Scottsdale, AZ
Alan Glenn — Fulbright & Jaworski, Austin, TX

DESCRIPTION OF THE PROPOSED ACTION

The project description provided in this biological opinion is non-discretionary and legally binding. Failure to conduct any portion of the action as described in this opinion would constitute project modification and, as provided in 50 CFR §402.16, would require reinitiation of formal consultation. Should any portion of the project be modified from the description provided below, the Service should be notified immediately.

The proposed Federal action is the issuance of a Corp permit to WLC Green Valley Limited Partnership and Fairfield Green Valley, Inc. and their respective successors and assignees to enable the development of the Las Campanas master-planned community. The permit authorizes the discharge of fill material into 2.7 ha (6.6 acres) of unnamed washes that cross the 215 ha (532 acres) area for the purpose of developing road crossings and residential housing units. The proposed and approved density by Pima County ranges from 3 to 18 units per acre. Further, zoning on the property allows for 5.1 ha (12.5 acres) of commercial development which is planned to be a community center; and 34 ha (84 acres) of open space which will not be directly altered by development. However, as shown within the mitigation plan the hydrology within the open space will likely be indirectly affected. Thus, approximately, 181 ha (448 acres) of the project area will be commercial or residential development with the issuance of the permit.

Prior to consultation with the Service, development of 27 ha (72 acres) was underway when the Corps requested section 7 consultation from the Service. An additional 8.1 ha (23 acres) within a development block designated G1 was authorized by the Corps following a site visit with the Service to evaluate the area as potential habitat for the species. The vegetation, sandy soil substrate, and extremely dissected nature of fine, small drainages did not appear by the Service to be potential habitat within the G1 Block. The removal of the 35 ha (95 acres) G1 block as potential habitat leaves the remaining 437 acres to be evaluated in this biological opinion. With the use of the aerial photograph showing the distribution of Pima pineapple cactus across the project area and by considering the undeveloped, open space corridors, it appears that approximately 353 acres of Pima pineapple cactus habitat will be developed and absorbed by this proposed project.

The project is located in Section 10, T18S, R13E, Green Valley, Pima County, Arizona in the Santa Cruz Valley at elevations that range between 884 m (2900 ft) and 993 m (3060 ft). The vegetation in this area exhibits characteristics of; the Arizona upland subdivision of Sonoran desert-scrub, and semi-desert grasslands described by Brown (1982).

The land area drains in an eastward direction towards the Santa Cruz River through two dissected wash systems with overland sheet flow across the majority of the area. Over time this hydrological activity has created an alluvial soil substrate from the granitic parent material.

Within this project area three general topographical (GT) types can be delineated for the purposes of this biological opinion:

General Topographical Classifications

GT1) sandy wash bottoms in relatively deep and moderately discrete drainage systems which are not likely to be associated with Pima pineapple cactus,

GT2) finely networked systems with many small drainage areas and very sandy soils which are also not likely to support Pima pineapple cactus,

GT3) upland areas with sandy, loam, clay soils which were found to support Pima pineapple cactus.

In the project area, all known Pima pineapple cacti (N=46 individuals) were found outside of the sandy wash bottoms such as GT1 represents and the sandy soils associated with fan-like systems of GT2. All of individual clusters and widely scattered individuals of the species were found occupying upland areas. Some individuals surveyed within the project area were located just within or immediately adjacent to the designated open space corridors, although locations were outside of a predicted 100-year storm event line which was a post project boundary line developed from a hydrology model by using the HEC-2 analysis. This predicted boundary line is depicted on a series of maps submitted to the Service within the mitigation plan. This model predicts the post-development 100-year storm event elevations. Apparently at this project site, areas supporting the Pima pineapple cactus appear to be located above the boundary line as they are generally located where the model suggests the ground to be high enough to be utilized for residential units and roadways.

At present, these open space corridors include at present portions of both GT1 and GT3 land types, as defined above, thus providing for sandy wash bottoms and clearly defined upland areas available as potential future Pima pineapple cactus habitat. All of the individuals within the land area proposed for development were determined to be unavoidably and directly impacted by the project and will have to be salvaged and transplanted into the open space corridors. Currently, the proposed open space areas outside the sandy drainage bottoms appear to be comprised of soils and vegetation where Pima pineapple cactus individuals might potentially survive, reproduce, recruit new individuals and provide future population viability if many other factors were not limiting within the new environment (i.e. pollinators, dispersal mechanisms, defense mechanisms against predators).

The submitted mitigation plan illustrating the predicted future hydrology within the open space corridors by using a HEC-2 analysis shows the majority of the open space corridors are comprised of land area which will allow for the drainage of the 100-year storm events coming off the adjacent and upper portions of the future residential development. Essentially, this map gives rise to the hypothesis that a potential and considerable change (i.e. the future open space corridors are predicted to contain approximately less than 95% of area above the 100-year storm event

elevation) in the relative abundance of appropriate, GT3 or upland habitat available as future habitat could result as the hydrological changes within the open space corridors. The current aerial photograph and map of surveyed individuals and vegetation and the mitigation plan map showing where the HEC-2 analysis shows the 100-year storm event boundary to be relative to the rest of the project area are available at this office at the address reference above. Habitat, as defined within this opinion, would be those landscape components which would allow the species to survive, reproduce, and recruit enough new individuals to sustain viable populations.

There is no available information to suggest this species can utilize the majority of the open space corridors as habitat, as most will likely be within the 100-year storm event drainage area. The Service, with the Corps and SWCA consultants, hired by the permit applicant, have developed a transplantation and monitoring program as part of this proposed action.

The transplantation and monitoring program is designed to discern some likely factors which could be limiting transplantation success and population viability within these types of open undeveloped spaces and for the purposes of this biological opinion and to be consistent with other related documents these areas hereafter will be referred to as "Experimental Safe Zones." All measures to avoid, minimize, and mitigate impacts of the proposed development include transplantation of Pima pineapple cactus into experimental safe zones, provision of money for GIS mapping, and provision of money for preparation of a Recovery Conservation Agreement. Details of these measures are presented below.

Experimental Safe Zones. The applicant will implement a transplantation program involving the transplantation and monitoring of individual Pima pineapple cactus unavoidably and directly impacted by the specific project into 34 ha (84 acres) of open space corridors. Re-location design and transplantation will follow the protocols listed below.

1. Re-location Design:
The re-location design is illustrated by map and described in text within the mitigation plan and aerial photograph which are available as part of the administrative record at this office at the address referenced previously.

An HEC-2 analysis was conducted to predicted the 100-year storm event post-proposed project within the delineated open space corridors. This delineated high ground within the corridors was chosen for the re-location sites and represents the experimental safe zone area.

Since this species is generally distributed in clusters and the pattern of population distribution may be important for successful pollination, spatial considerations were developed to try to mimic the population's pre-project distribution. This plant is dependent on some array of flying invertebrate pollinators, likely to be various native bees and honey bees and can not self-pollinate. It is not known if the pollinators ability to achieve successful pollination will be impacted by the re-location design or any other element related to the proposed project. Thus, the identified clusters of Pima

pineapple cacti would be re-located together to the closest proximate experimental safe area available.

2. Transplantation:
Solar orientation of each cacti will be noted and clearly marked.

Each plant will be dug so that damage to roots will be minimized (6-8 inches in depth under each plant).

Damaged roots will be pruned and dusted with powered sulphur.

Plants will be hardened off in a shaded and airy location protected from rodents for at least ten days.

Following the "hardening off period" each cactus will be transplanted into a suitable area within the undeveloped open space upland areas referred to as experimental safe zones.

Each cactus will be reoriented to its original orientation as determined prior to removal.

Each cactus will be planted to the same depth as it grew in its original location and soil will be pressed firmly around the cactus roots and base.

Irrigation requirements will be determined during post transplantation monitoring.

Transplanting will be avoided during active flower and fruit production. This period of time is from the first rain after June 15 that is greater than 3 millimeters until November 1.

3. Monitoring:
The Pima pineapple cactus population will be monitored for two years following transplantation of the cacti. The objective of the monitoring plan is to determine transplantation and reproduction success within the experimental safe zones within the proposed open space corridors. Criteria for evaluating transplantation success include transplant survival, evidence of new above ground biomass related to plant vigor, determination of fruit set, and evidence of recruitment of new seedlings into open space corridors. The following monitoring actions are provided below to assess how well the program performed at meeting the criteria both within a short-term interval at six months and over a longer period of time, annually, for a two-year period. At least a two-year monitoring period should be conducted to assess the success by observed survival of individual cacti because, as the topic has been documented by Bunting et. al (1980), cacti can live completely on stored reserves for up to a two-year period prior to exhibiting mortality.

3a. Short-term Monitoring:
Prior to transplantation the largest diameter of a plant cluster for tubercle tip to tubercle tip (not including the length of the center spine) will be recorded.

Locations of the transplanted individuals will be recorded and permanently marked.

The mean distance to the nearest neighbor will be calculated for pre- and post-transplantation conditions.

After transplantation, cacti will be monitored monthly for six months. This monitoring will record general conditions of the total population.

3b. Long-term Monitoring:
The monitoring actions within the six-month period are aimed at identifying direct impacts associated with transplantation and not accessing indirect impacts related to or caused by the proposed project. However, the two-year annual monitoring following transplantation may increase the likelihood of observing factors which could have indirectly impacted transplantation success by showing negative trends in the data over the longer interval allowed for observation. Or provide more certainty of transplantation success if no declines in the criteria are observed over the two-year period.

Following the six-month monitoring, long-term monitoring will be done twice annually pre- and post-monsoon season.

The post-monsoon monitoring will record the largest diameter and estimate seed production to observe and consider the long-term effects of transplantation.

A randomly chosen sample of 16 individual plants will be selected and a 50 m^2 quadrant will be established around each adult to enable searching for seedlings. To find seedlings, the quadrant will be searched slowly at ground level (i.e. survey crews on hands and knees).

3c. Reporting:
The reports will describe the survival and reproductive success associated with this transplantation design and protocol within the experimental safe zones. After analysis of the results of the post-transplantation monitoring, a report will be produced. An annual report will be produced following the analysis of post-monsoon monitoring results for a two- year period following transplantation. Monitoring reports will note observations relating to mortality or apparent illegal collection.

3d. Specifications within the Experimental Safe Zones:
The necessary restrictions to prevent off-road motor vehicle and mountain bike use within the safe zones will be implemented. These may include the placement of signs or fencing. Any future activities proposed to occur within the experimental safe zones will be coordinated with the Service so as to avoid potential impacts to Pima pineapple cactus.

GIS Grant. A critical component of developing and implementing a plan for the recovery of the Pima pineapple cactus is the formation and utilization of mapping tools to document habitat

locations and spatial relationships among features of interest such as residential development and mining operations. Creating the mapping tools will require input and analysis of information based upon the global information system (GIS). In order to further this effort, and thereby increase the likelihood of the survival and recovery of the species, the applicant will provide to the Service or its designated conservation or research entity a grant in the amount of $12,000.00 towards formation of the GIS mapping effort.

Recovery Conservation Agreement. Establishment of a Recovery Conservation Agreement is perceived as an important step towards ensuring recovery of the Pima pineapple cactus. In order to increase the likelihood of recovery of this species, the applicant will provide seed money in the amount of $4000.00 for the organization of a Recovery Task Force involving relevant stakeholders. In addition, subject to time and economic constraints, the applicant agrees to participate either directly or through a designee in the recovery planning process.

STATUS OF THE SPECIES (Range-wide)

Life History

The final rule listing Pima pineapple cactus as endangered was published September 23, 1993 (58 FR 49875). The rule became effective on October 25, 1993, and critical habitat was not designated at that time. Factors which contributed to the listing include habitat loss and degradation, habitat modification and fragmentation, distribution characteristics and plant rareness, illegal collection, threats, and difficulties in providing protection of an areas large enough to maintain functioning populations. The biological information below is summarized from the proposed and final rules, and other sources.

Pima pineapple cactus is a low growing hemispherical cactus with adults varying in stem diameter from 5.0 cm (2.0") to 21.0 cm (8.3") and height from 4.5 cm (1.8") to 45.7 cm (18.0"). Individuals are considered adults when they reproduce sexually through flowers. Plants can be either single or multi-stemmed with yellow flowers blooming with the summer rains. Clusters of Pima pineapple cactus stems are formed primarily from vegetative clones produced at the plant base (Benson 1982, Roller 1996). The diagnostic characteristic of this taxon is the presence of one stout, straw-colored, central spine which is hooked. Radial spines extend laterally around the central spine and average 10 to 15 spines on large cacti and six on small cacti (Benson 1982).

Pima pineapple cactus occurs south of Tucson, in Pima and Santa Cruz counties, Arizona and adjacent northern Sonora, Mexico. It is distributed throughout both the Altar and Santa Cruz Valleys and in low lying areas connecting the two valleys.

Groups of flowers begin to bloom for single day periods following five to seven days after the first monsoon rains. Research has indicated flowering is triggered by as little precipitation as 3 mm. Generally flowers begin opening mid-morning and close at dusk. Adult plants will bloom one to three days each year, flowering is usually over by the end of August. Cross-pollination produces significantly more viable seeds than self-pollination. Fruits are mature within two weeks

following successful pollination. Germination has been observed in the field during the summer monsoon rainy season (Roller 1996). Anecdotal observations indicate the species' flowers are visited by a variety of native bees and European honey bees which leave the flowers with their forehead and hind legs covered in Pima pineapple cactus pollen.

Habitat fragmentation and isolation may be an important factor limiting future seed set of this cactus. Recent data shows that the species cannot self pollinate and is reliant on invertebrate pollinators. One hypothesis could suggest that the spatial distribution pattern of individual Pima pineapple cacti within a given area may be related to pollinator visitations, thus resulting in more successful cross-pollination and subsequent seed set over the population (Roller 1996).

Population Stability

Using recent survey (1992-1997) information regarding Pima pineapple cacti locations, an extrapolated total population size for the species might appear to be much greater than actual on the ground, standardized observations would reveal. This taxon is extremely rare when numbers of known individuals are applied across its range. Pima pineapple cactus is widely dispersed in very small clusters across land areas which are well suited for residential, commercial or mining development. As well, field observations suggest a great deal of land area within the range boundaries does not support Pima pineapple cactus due to historic human impact or some other environment constraint. Thus, populations are already considerably isolated from each other in specific portions of the range and population size and apparent recruitment vary significantly across the range. Population variability may relate, as observed on a more local scale; to habitat development, modification, and/or other environmental factors such as slope, vegetation, pollinators, dispersal mechanisms, etc.

Habitat which contains denser populations, better recruitment, and individuals exhibiting greater plant vigor, represents a transition zone between the two regions of vegetation described by Brown (1982)as semi-desert grassland and Sonoran desert-scrub. Vegetation within this transition zone has been characterized as being dominated by mid-sized mesquite trees, half shrubs (snakeweed, burroweed, and desert zinnia) with patches of native grass and scattered succulents. Because populations are healthier in this transition zone, conservation within these areas is very important (Roller and Halvorson 1997). However, this important habitat type is not uniformly distributed throughout the plant's range. Populations of Pima pineapple cacti are patchy, widely dispersed and highly variable in density. The higher population densities have only been documented at three sites. Compared to other surveys, two of these sites are very small in scale and range from 6.3 and 7.5 plants per ha (3 to 1 plant per acre). This fact may tend to skew the interpretation of plant distribution. Other densities across the majority of the plant's range vary between one plant per 1.9 ha (1 per 4.6 acres) and one plant per 8.5 ha (1 per 21 acres) (Mills, 1991; Ecosphere, 1992; Roller, 1996).

Land areas surrounding developed parts of Green Valley and Sahuarita, Arizona; and those same areas of the San Xavier District of the Tohono O'Odham Nation may be very important for the conservation of this species within its range. Analysis of surveys conducted from 1992 to 1995

with a multi-variate, quantitative statistical analysis established a pattern of greater population densities, higher ranks of cactus vigor and reproduction occurring within the transition vegetation type found in this area of the northern Santa Cruz Valley. This area could be defined as an ecotone boundary between semi-desert grasslands and Sonoran desertscrub.

Seedling and sub-adult size classes are not common throughout populations across the range and could be a function of simply not finding such small, well camouflaged plants in a large-scale survey, or because the establishment phase of the seedling may be limited in some unknown way. Research on Pima pineapple cactus reproduction has suggested that the establishment phase of Pima pineapple cactus life history may be limiting recruitment within populations. Evidence presented to support this conclusion was the abundance of flowers, fruits and viable seed, and the rarity of seedling presence at different sites spread through the plant's range (Roller 1996). Other research has documented the establishment phase of other Sonoran cacti species as being critical to survival to reproductive maturity (Steenbergh and Lowe 1977).

Status and Distribution

Generally, the Pima pineapple cactus grows on gentle slopes of less than 10% and along the tops (upland areas) of alluvial bajadas nearest to the basins coming down from steep rocky slopes. The plant is found at elevations from 720 m (2362 ft) and 1440 m (4593 ft) (Phillips et al. 1981, Benson 1982, Ecosphere Environmental Services, Inc. 1992) in vegetation characterized as either or as combination of both the Arizona upland of the Sonoran desertscrub and semi-desert grasslands (Brown 1982).

The acquisition of baseline information began with surveys documenting the presence of Pima pineapple cactus as early as 1935. More intensive surveys were initiated in 1991 and other research established in 1993 further investigated the reproductive biology, distribution, fire effects and mortalities associated with various threats. Therefore, the best available baseline information is relatively recent and may not represent actual changes in distribution since the declines in the status of the species began. Population degradations and actual changes were likely greater than the numbers are presented here in such a narrow time frame. Further, demographic monitoring across the range will be important for the further development of this baseline information and for management purposes the spatial representation of those trends needs to be developed.

Widely scattered surveys were conducted across sites which varied considerably in density between 3 plants per 0.4 ha (1 acre) and 1 plant per 9.0 ha (24 acres). Approximately 50 townships can be delineated within the U.S. range boundaries. However, a considerable amount of land area within the range boundaries due to elevation, topography, hydrology, plant community type, and human degradation does not likely provide habitat for the species. With 22,959 ha (56,730 acres), close to 10 to 20 percent of the U.S. range area surveyed, a current total of 3805 individuals have been located since 1935, with the majority since 1991 using a more intensive methodology.

It is important to clarify that the above number represents the total number of locations ever found and not the current population size. The quantity which documents the observed and authorized mortalities and transplantations of individuals since the species was listed in 1993 to present, is 2173 individuals which equals nearly 60 percent of all known locations. A small portion of these mortalities are not associated with any specific human activity. These monitoring results are a sample developed to represent the range-wide status of the Pima Pineapple Cactus which appears to have been recently impacted with threats which have caused the elimination of over half of the documented locations.

Transplanted individuals at this time are not be considered as individuals functioning within the context of a self-sustaining population. It is the Service's hope that future monitoring will suggest that the experimental safe zones and transplantation design will facilitate the restoration of viable populations with stable demographics. Although, until information suggests that we are successful at this restoration effort transplanted individuals will be not be counted as operative units of the entire population. Further, once individuals are transplanted from a site it is considered to be extirpated as those individuals functioning in that habitat are irretrievably lost.

The area of habitat impacted or authorized to be impacted across a ten year period between 1987 and 1997 (i.e. habitat developed or significantly modified beyond the point where as restoration would be a likely alternative) was roughly 8,702 ha (23,843 acres) which represents 38% of our area ever surveyed. Based on current knowledge, the following threats documented with this reduction in habitat are viewed as altering the landscape in manner that would be nearly irreversible in terms of supporting Pima pineapple cactus populations: urbanization, farm and crop development, exotic species invasion with fire. Monitored land areas which appear to support Pima pineapple cactus populations without evidence of fire and exotic species invasion, overgrazing, and off-road vehicle use, and with evidence of reproduction of healthy new individuals, were not considered to be modified.

Other specific threats which have been previously documented (U.S. Department of Interior 1993) such as overgrazing and mining have not yet undergone a complete synthesis of the past impacts, however, partial information does exist and can be applied. Mining has resulted in the loss of hundreds, if not thousands, of acres of potential habitat throughout the range of the species. Much of the mining activity has been occurring in the Green Valley area, which is the center of the species' distribution and the area known to support the highest densities of individuals.

Most of the documented habitat development has occurred south of Tucson down through the Santa Cruz Valley to the town of Amado. This area is critical for the future recovery of the species. The expansion of urban centers and mining activities will continue to eliminate habitat and individuals, and result in habitat fragmentation.

The protection of habitat and individuals is complicated by the varying land ownership within the range of this species. An estimated 10 percent of the potential habitat for Pima pineapple cactus is held in Federal ownership. The remaining 90 percent is on Tribal, State, and private lands. Most of the federally-owned land is either at the edge of the range or in scattered parcels. The

largest contiguous piece of federally-owned land is the Buenos Aires National Wildlife Refuge, located at the southwestern edge of the species range at higher elevations and lower plant densities.

Under Section 9 of the Act, the taking of listed animals is specifically prohibited. These prohibitions apply regardless of landownership status. For listed plants, these prohibitions and the protection they afford do not apply. Listed plant species are only protected from deliberate removal from Federal lands. There is no protection against removal from, or destruction of plants on, any non-Federal lands under the Act by a land owner. The Arizona Native Plant Law may delay vegetation clearing on private property for the salvage of specific plants species within a 30-day period. Although, State Native Plant Law does prohibit the illegal taking of this species on state and private lands without a permit for educational or research purposes, it does not provide for protection of plants existing in place through restrictions on development activities.

Section 7 protection extends to listed plants regardless of landownership. However, without Federal agency involvement, section 7 does not apply to projects on non-Federal lands. Much of the development likely on State or private lands has a limited exposure to Federal regulatory requirements. Additional Pima pineapple cacti and associated habitat on these lands are almost certain to be lost to as development in southern Arizona continues through the Santa Cruz Valley. Efforts to transplant individual cacti to other locations have had only limited success and, as development increases, other locations will become less evident as habitat is converted.

The entire approach to transplanting Pima pineapple cactus involves three general phases: salvage operations which include hardening-off techniques, replanting techniques, and the selection of suitable habitat to sustain viable populations. Research has determined successful methods for conducting the first two phases involving the salvage and replanting preparation techniques (Margaret Livingston, pers. comm., School of Renewable Natural Resources, The University of Arizona, Roller 1996). However, the third phase involving habitat selection and the re-planting spatial design has been unsuccessful and further study is necessary if transplantation is ever to be considered a viable option for plants impacted by land development. Although an effective transplantation approach involving successful application of all three phases may reduce impacts affecting individual cacti, it will not reduce impacts associated with the reduction of habitat altered by development.

Based on surveys and habitat analysis, the land areas which spread from south of Tucson down through the Santa Cruz Valley to the town of Amado and surrounding developed parts of Green Valley and Sahuarita, and parts of the San Xavier District of the Tohono O'Odham Nation, appear to support abundant populations, some recruitment, and units of extensive habitat still remaining. However, the primary impact which has contributed to the status of this species throughout its range is the most recent rate (i.e. since 1993) at which habitat is being developed, fragmented or modified as has been observed in this general area.

Overgrazing by livestock, illegal plant collection, and fire-related interactions involving exotic Lehmann lovegrass (*Eragrostis lehmanniana*) are also threats which may negatively affect Pima pineapple cactus populations (U.S. Department of Interior 1993).

Very little is known regarding the effects of low to moderate levels of livestock grazing on Pima pineapple cactus distribution. Currently, a study has been established to observe the effects of grazing on Pima pineapple cactus at the Coronado National Forest. Livestock grazing practices are quite variable. This taxon is patchy in distribution and widely dispersed and occupies relatively xeric soils (i.e. these plants do not inhabit areas immediately adjacent to or along water tanks or streambanks) (Roller 1996) which are not often used by livestock managed at lower stocking rates with increased rotations and periods of pasture rest. However, areas which are overgrazed may threaten populations by increasing the probability of trampling and significantly altering the hydrology which may affect seed dispersal or seedling establishment. Habitat effects of livestock overuse could include erosion, hydrologic and micro-climatic changes, invasion or expansion of exotic grasses due to livestock preferences for native grass species over exotics. Some range management practices such as mechanical imprinting, chaining, ripping, and seeding of nonnative grasses have contributed to the modification and loss of habitat and individual cacti. Overgrazing in some areas continues today.

To what extent overgrazing may directly or indirectly effect the cactus by impacting the structure and function of the ecosystem has not been identified. However, long-term grazing, primarily overgrazing, fire suppression, and drought in arid grassland ecosystems have all been hypothesized as being the cause, either individually or collectively, of changes in arid grassland community structure and function (Bahre 1985). Altered edaphic (stability and water infiltration ability) conditions, caused by damage to micro-biotic and cryptogamic crusts over soils with grazing, have been documented in arid land systems (Schlesinger et al. 1990, Fleischner 1994).

Even with data on historical change related to Pima pineapple cactus distribution and abundance (not intended to infer we do not have data reflecting recent changes in the species distribution and abundance), which is not available, we cannot reliably predict cause and effect scenarios for the future due to compounding factors such as climate change, urbanization, legal and political complexities (McPherson 1995). We do not know if the majority of populations of Pima pineapple cactus can be sustainable, as the plant communities throughout the range of the plant are currently structured and functioning. Thus, the need for information on what is limiting this plant's distribution under current habitat conditions is important.

Vegetation associated with higher Pima pineapple cactus densities, reproduction and greater levels of cactus vigor is described as a mid-sized mesquite shrubland with an assortment of other succulent species and native bunch grasses. Many of the species dominant in this vegetation type are associated with grazing (i.e. are known as "increasers" under some grazing practices). Less grazed pastures did support greater native grass coverage with more species present. However, even with an increased bunch grass abundance, the fuel structure of the community was not continuous and allowed for substantial open patches along the drip line of shrub species where the cactus often occurs (Roller and Halvorson 1997). Also, specific levels of soil movement are required for seed germination because the seed will not germinate on the surface; it generally germinates at a depth between 0.5 cm to 1.5 cm (0.2" - 0.6") (Roller 1996). Few locations throughout the plant's range have documented the presence of seedlings or sub-adults. However, all but one of the known locations had been grazed within three years of the observation. Whether

light to moderate grazing practices provides the appropriate level of soil movement to cause seed germination has not been determined. Over-land sheet flow across these areas may also serve to move soil and deposit it over sediments. The study established on the Coronado National Forest should provide some insight on seed germination relative to specific grazing intensities.

Reduced herbaceous biomass within the immediate proximity of individuals may reduce heat intensity with fire. Reduced herbaceous cover, distributed continuously, decreases fire frequencies in semi-desert grasslands which over the long-term increases cactus survival following fire (McPherson 1995, Thomas and Goodson 1992), and limits fire uniformity within burned areas due to the discontinuity of fine fuels (Wright and Bailey 1982).

The invasion of Lehmann lovegrass combined with fire is a threat to Pima pineapple cactus populations. Continuous distribution of fuels and greater biomass near the apex of individual plants have been hypothesized as increasing mortality following fire (Roller and Halvorson 1997). Research shows that fire increases Lehmann lovegrass distribution and suggests fire intensity and fire frequency increases with Lehmann lovegrass invasion (McPherson 1995).

Based on the monitoring results, the range-wide status of the Pima pineapple cactus appears to have been recently impacted with threats which completely alter or considerably modify over a third of the species' surveyed habitat and has caused the elimination of nearly 60 % of the documented locations. These values are supplied to serve as an extrapolation of the situation which might be taking place across the rest of the entire population. Current information regarding the status of this species is in great need of more precise and thorough spatial analysis through the use of geographical information systems and databases than is available at present.

As discussed prior, the widely scattered distribution of the species surviving at low densities within the occupied habitat results in small populations widely spread across the known range. These clusters of individuals are becoming increasingly isolated as urban development, mining, and other commercial activities continue to detrimentally impact the habitat. The remaining habitat also is subject to degradation or modification from current land management practices, increased recreational use when adjacent to urban expansion (i.e. off-road vehicle use and illegal collection), and the continuing aggressive spread of nonnative grasses into its habitat. Habitat fragmentation and degradation will likely continue into the foreseeable future based on historic data and growth projections produced by the Pima County Association of Governments in their 1995 Population Handbook. There is very little Federal oversight on ways to provide conservation measures that would protect or recover the majority of the potential habitat. Even some areas legally protected under the Act have been modified and may not be able to support viable populations of the Pima pineapple cactus over the long-term.

ENVIRONMENTAL BASELINE

Status of the Species (In the Action Area)

The environmental baseline includes past and present impacts of all Federal, State, or private actions in the action area, and the anticipated impacts of all proposed Federal actions in the action area that have undergone formal or early Section 7 consultation. It also includes the impact of State and private actions which are contemporaneous with the consultation process. The environmental baseline defines the current status of the species and its habitat in the action area to provide a platform to assess the effects of the action under consultation.

The anticipated impacts of a Federal action considered by the Service to be within the action area as it is within close proximity to the Northern boundary of the of the proposed project and within the primary area which will likely be indirectly affected by the proposed increased growth associated with residential development. Immediately adjacent to the northern boundary is residential development. However, undeveloped potential habitat for the species is present near the northern edge of the project and anticipated effects of the proposed action would contribute 405 more Pima pineapple cacti to be transplanted and the mining development of 799 ha (1975 hectares) of surveyed habitat and increasing the area of impacted habitat. An agency action can be removed from the environmental baseline (i.e. status of the species in the action area) if the action agency proposing the project notifies the Service in writing that a previously proposed project action will not be implemented.

Mine tailings are found along the western edge of the proposed project and this historical impact was covered under the range-wide analysis of the status of the species. Residential development and public facilities bound the project area along the southern and eastern boundaries. This areas likely once served as Pima pineapple cactus habitat; however, with land conversion do not now appear to be suitable.

EFFECTS OF THE ACTION

The proposed action will result in the loss of 353 acres of habitat. Three of the four project area boundaries are currently surrounded by converted habitat which would suggest that this specific habitat may already be subject to impacts related to fragmentation and urbanization. Although potentially degraded, this area does bound undeveloped potential habitat to the West and is within a region of the species' range where conservation related to its survival and recovery is very important. This general area which extends south of Tucson down through the Santa Cruz Valley to the town of Amado in Pima County, Arizona represents a transition zone or ecotonal boundary of vegetation which has been found to support high plant densities, better recruitment, and greater plant vigor than other vegetation types described with Pima pineapple cacti.

Both adverse direct and indirect impacts will occur to Pima pineapple cactus. Forty seven individuals of varied size classes are supported by approximately 437 acres of suitable habitat. The total project area is 532 acres, of which 95 acres were evaluated as not being potential habitat and approximately, 84 acres were designated as open space corridors which encompassed drainages, areas predicted to be within the 100-year flood event and a minimal amount of upland area outside the boundary line. Using a post project hydrology model, the open space corridors will likely be comprised primarily of land area which will be subject to hydrological changes (i.e.

available to drain the residential area of flows related to 100-year storm events) which have not been documented with Pima pineapple cactus. It is not known at this time if habitat which is generally referenced as upland areas are also subject to 100-year storm events. These upland habitats are associated with overland sheet flow during storm events in general. Essentially, the Pima pineapple cactus is not found in drainage bottoms, along drainage banks, or in flood-plain areas. However, individuals are often near smaller drainages which braid down along the bajada, as they are up on knolls or rises above them.

The majority of the open space presently contains two individuals and appears to be continuous upland habitat available for Pima pineapple cactus distribution. However, the future model predicts that hydrological changes will occur and it is not certain that this area will provide sufficient habitat to sustain the population in the future. Specific factors which have been hypothesized based on field observations to be limiting the transplantation and habitat selection for these types of restoration efforts have been the following: selected habitat size, spatial distribution and re-planting design, predation, pollination, drought and illegal collection. Therefore, a transplantation and monitoring program was designed to discern some likely factors which could be limiting transplantation success and population viability within these types of open undeveloped spaces and for the purposes of this biological opinion and to be consistent with other related documents these areas hereafter will be referred to as "Experimental Safe Zones". This information is compelling as it may aid in restoration efforts of degraded habitat. Investigating these various approaches by which we can manage self-sustaining populations within an urban environment is one of many questions important for the recovery of this cactus.

New root systems, above ground biomass and reproductive structures such as flowers, fruits and seeds within the first year or growing season have been documented for transplanted individuals using the transplantation protocol identified in the mitigation plan provided by the applicant. However, in the second year under drought conditions, an estimated 70% mortality with anecdotal observations of predation occurred (Margaret Livingston, pers. comm.). Therefore, the experimental transplantation into safe zones may result in the direct mortality of 47 individuals and result in the loss of 353 acres (532-95-84 = 353) of habitat.

Indirect effects could result from the unplanned but anticipated use of the open space by the local residential community. The safe zone will be available for recreational activities including hiking and biking. However, information presented in the project description of this opinion require necessary restrictions to prevent recreational impacts out of experimental safe zones.

Demographic monitoring and the development of a spatial representation database relevant to the conservation and management of the Pima pineapple cactus is a fundamental component needed for the species survival and recovery. Establishing mapping tools based upon the global information system will enable a more reliable assessment of the species status and future conservation strategies.

The proposed project will provide to the Service or its designated conservation entity a grant in the amount of $12,000.00 towards the creation of the GIS database. This database will incorporate

monitoring information related to population demographics at sites across the plant's range, land ownership, permitted zoning, potential and occupied habitat, land management, and relevant conservation actions which have been implemented to aid future management decisions related to the conservation of the species. This contribution will provide needed tools for the Service to facilitate Pima pineapple cactus survival and recovery.

Additionally, a recovery program and conservation agreement is needed to begin and ensure the future commitment for recovering this endangered species. In order to increase the likelihood of the recovery of the Pima pineapple cactus, the permit applicant will provide seed money in the amount of $4000.00 to the Service's designated conservation entity for the organization of a Recovery Task Force involving relevant stakeholders. In addition, subject to time and economic constraints, the applicant agrees to participate either directly or through a designee in the recovery planning process.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, local or private actions that are reasonably certain to occur in the action area being considered in this biological opinion. Federal actions that are unrelated to the proposed action are not considered as cumulative impacts because they require separate consultation pursuant to section 7 of ESA.

As discussed in the BA, this project is surrounded by residential and commercial developments on three out of four boundaries. The primary direct effects of future actions which are reasonably certain to occur based on the 1995 Population Handbook for Pima County referenced earlier are the residential and commercial development of remaining potential habitat lying to the west of the project boundary and the mining development of nearby habitat to the North of the proposed project, but within the action area.

BIOLOGICAL OPINION

After reviewing the current status of Pima pineapple cactus, the environmental baseline for the action area, the effects of the proposed housing development, and the cumulative effects, it is the Service's biological opinion that the issuance of the permit to allow the housing development to proceed as proposed is not likely to jeopardize the continued existence of the Pima pineapple cactus. No critical habitat has been designated for this species, therefore, none will be affected.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of ESA directs Federal agencies to utilize their authorities to further the purposes of ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid

adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The recommendations provided here relate only to the proposed action and do not necessarily represent complete fulfillment of the agency's section 7(a)(1) responsibility for this species. Actions proposed as part of the proposed project are not included here. The Service recommends the following actions:

A. A permitted researcher hired by the Service through section 6 funds to study Pima pineapple cactus is interested in observing the salvage operations conducted as part of this proposed project. Specifically, he would like to carefully excavate a few individuals to look at their below ground root architecture as it relates to gathering nutrients from micro-biotic organisms manufactured by ants and/or banner-tailed kangaroo rats. If interested in allowing this type of work please contact our Botanist, Tricia Roller from our Tucson Sub-office at (520-670-4859).

B. Establish a residential community group to learn from and participate with the licensed and permitted biologists hired to fulfill monitoring requirements of this biological opinion. This community group could also contribute more knowledge towards Pima pineapple cactus conservation by conducting additional observations or measurements while the required monitoring was being conducted. Upon completion of the required monitoring this local group could continue to monitor the experimental population and document the demographic trends across a greater span of time. The Service as well as many other local City and County, State and Federal public agencies would be interested in such long-term observations of such a population. Site specific information relative to the effort should be left out of such documentation, due to threats upon this species from illegal collection. The following list provides specific types of additional observations which could be made by such a group with a more local perspective:

1. **Flower Watch**: Plants could be monitored and once flowering occurred the group could count the number of flowers and number of different types of pollinators that visited and left with pollen attached to their body parts.

2. **Fruit Count**: Count the number of fruits produced and removed by birds, rabbits, and rodents from individual plants.

3. **Search for New Plants**: Search plots for small individuals (i.e. seedlings and juveniles).

4. **Watch for Invaders**: Search open space corridors for exotic and invasive species, then observe and report their spread.

5. **Relationship observations**: Look for symbiotic relationships between the plants and other creatures (i.e. are ant colonies or banner-tailed kangaroo rats moving in near to Pima pineapple cacti sites, what animals are eating the fruits, are new plants found near areas where animals live, etc.).

INCIDENTAL TAKE

Sections 7(b)(4) and 7(o)(2) of ESA do not apply to the incidental take of listed plant species. However, protection of listed plants is provided to the extent that ESA requires a Federal permit for removal or reduction to possession of endangered plants from areas under Federal jurisdiction, or for any act that would remove, cut, dig up, or damage or destroy any such species on any other area in knowing violation of any regulation of any State or in the course of any violation of a State criminal trespass law.

CLOSING STATEMENT

This concludes formal consultation on the proposed action outlined in the request. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) new information reveals effects of the agency action that may affect Pima pineapple cactus in a manner or to an extent not considered in this opinion; (2) the agency action is subsequently modified in a manner that causes an effect to the Pima pineapple cactus that was not considered in this opinion; or (3) a new species is listed or critical habitat designated that may be affected by the action.

For further information, please contact Tricia Roller or Angie Brooks. Please refer to the consultation number 2-21-96-F-134 in future correspondence concerning this project.

Sincerely,

For Jerry Brabander
Acting Field Supervisor

cc: Regional Director, Fish and Wildlife Service, Albuquerque, NM (GMA)(ES)
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William Halvorson, BRD/USGS/CPSU, University of Arizona, Tucson, AZ
Julia Fonseca, Conservation Chair, Arizona Native Plants Society, Tucson, AZ
Director, Arizona Department of Agriculture, Phoenix, AZ

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